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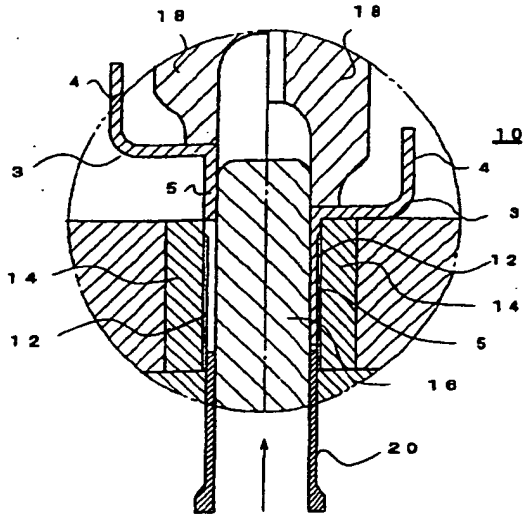
(54) TORQUE TRANSMITTING MEMBER IN AUTOMOTIVE TRANSMISSION, METHOD FOR FORMING SPLINE TEETH, AND APPARATUS FOR FORMING THE SAME

(57) A method for forming spline teeth (12) on the outer periphery of a cylindrical part (5) of a work having the boss (5) integrally formed at the center of a metallic disk plate (3a), which comprises disposing the work so that the boss (5) fits with a boss guiding mandrel (16) arranged at the center of a cylindrical die (14) on which the teeth (12) for ironing spline teeth are formed, pressing the disk plate (3a) with a punch, fitting the boss (5) into a gap between the die (14) and the mandrel (16), and forming spline teeth (5a) on the external periphery of the boss (5) by ironing.

FIG. 2



(Enlarged view of Portion "A")

EP 0 989 316 A1

Description

TECHNICAL FIELD

[0001] The present invention relates to a method and the equipment for forming spline teeth on the outer circumference of a cylindrical boss integrally formed at and protruding from a disk plate.

BACKGROUND ART

[0002] FIG. 8 shows a prior art carrier plate assembly used for an automatic transmission for an automobile. In the same drawing, a carrier plate assembly 1 consists of a ring-like base plate 2 and a carrier plate 3 integrally formed on the base plate 2 by welding.

[0003] The carrier plate 3 is a press-formed body, in which wall portions 4 connected to the base plate 2 are formed to collapse at three points around its circumference, and a boss portion 5 is formed to stand upright at the center thereof.

[0004] In addition, three planetary gears 6 are supported, by bearings, between the surrounding portion of the carrier plate 3 between the respective wall portions 4 and the base 2, and the inside and outside of the respective planetary gears 6 are engaged with the sun gear and internal gears which are not illustrated herein.

[0005] Also, since the boss portion 5 is connected to the axial end of an output shaft 7, spline teeth 5a which are engaged with inner spline grooves 7a on the inner circumference of an engaging hole of the output shaft 7 are formed on the outer circumferential surface.

[0006] A cutting and machining method illustrated in FIG. 9 has been utilized in prior arts as a method for forming the spline teeth 5a.

[0007] First, in the initial process, as shown in (a), a press-worked part is produced, in which wall portions 4 are press-formed at three points on the circumference, and a boss portion 5 is press-formed at its center position. As shown in (b), a tapered part 5b and a grooved part 5c are produced thereon by tapering the tip end thereof and grooving the root thereof by cutting. After that, a cutter of a shaving machine is caused to reciprocate in the axial direction of the boss portion 5 whenever the carrier plate 3 stops while intermittently rotating the carrier plate 3 at an appointed degree of angle, whereby, as shown in (c), spline teeth 5a are formed.

[0008] However, there exist the following problems and shortcomings in the prior art spline teeth forming method described above.

[0009] First, since there are a number of processing steps in order to form spline teeth by cutting, production costs are expensive, wherein different processes consisting of a press-working process and a cutting process are indispensable. Therefore, automatic continuous production could not be carried out.

[0010] Further, a grooving process is requisite at the root part of the boss portion in order to secure relief for a cutter which produces spline teeth, whereby the root of the boss portion 5 of the carrier plate is unavoidably made thin. Stress is likely to be concentrated at this part when transmitting torque, whereby the structure is unavoidably made brittle.

[0011] Still further, since the abovementioned machining is to shave surfaces, surfaces machined and hardened by press-working, which is a pre-process of shaving the surfaces, and a material flow are discontinued. Therefore, the hardness of a part which was shaved is made low, and the surface strength of the carrier plate boss portion is lowered, whereby such a shortcoming is produced by which a finished part is likely to be easily worn.

[0012] The invention was developed in order to solve the abovementioned problems and shortcomings, and it is therefore an object of the invention to provide a torque transmitting member for an automobile, which has a high surface hardness and spline teeth, a method for forming spline teeth, and equipment for forming spline teeth, in which the same method is utilized.

DISCLOSURE OF INVENTION

[0013] In order to achieve the above object, a torque transmitting member for an automobile according to Claim 1 is a torque transmitting member in an automobile transmission, having a cylindrical boss integrally formed at the center of a metallic disk plate and having spline teeth formed on the outer circumference of said boss, wherein the spline teeth are formed so that their outer-layered portion is drawn from the tip end side of said boss in the axial direction. For example, the torque transmitting member is applicable to a carrier plate for automatic transmissions, in which wall portions welded to and fixed at a base plate are provided at a plurality of points in the circumferential direction.

[0014] The spline teeth formed on the outer circumference of the boss are drawn in the axial direction from the tip end side of the boss to the root side thereof when forming the spline teeth, and the material is caused to flow in the axial direction due to a drawing process. However, as shown in FIG. 6(a), the texture in the cross section thereof becomes such that a plurality of layers continued in the circumferential direction are laminated, and the surface hardness thereof is harder than prior art teeth (refer to FIG. 6(b)) in which a plurality of layers continued in the circumferential direction are separated from each other. Also, the drawn material is accumulated at the root portion of the boss, whereby the hardness at the root portion of the boss becomes a maximum, and a sufficient thickness can be secured at the root portion of the boss.

[0015] Further, a method for forming spline teeth according to Claim 3 is constructed as a method for forming spline teeth on the outer circumferential surface of a boss of a workpiece on which a cylindrical boss is integrally formed at the center of a metallic disk plate,

wherein with respect to a cylindrical die on which teeth for drawing and forming spline teeth are formed, and a boss guide mandrel disposed at the center of said die, a disk plate for a workpiece, in which the boss is disposed so as to be fitted into the mandrel is pressed by a punch, the boss is fitted in a clearance between the die and the mandrel, and spline teeth are drawn and formed on the outer circumferential surface of the boss. The outer layer portion of the boss is drawn in the axial direction by forcing a boss of a workpiece to be pressed in a diet, and teeth are formed while flowing the material toward the root portion side of the boss. That is, a one-shot operation of a punch completes formation of the spline teeth.

[0016] In addition, equipment for forming spline teeth according to Claim 4 is provided with a cylindrical die on which teeth for drawing and forming spline teeth are formed; a boss guide mandrel, which is disposed and fixed at the center of said boss; and a punch which is elevated along said mandrel and causes a boss engaged in said mandrel to be inserted into a clearance between said die and said mandrel, wherein the mandrel functions as an initial positioning member of a workpiece, and at the same time, functions as a guide for pressing the boss into a die and operates as a forming surface inside the boss.

BRIEF DESCRIPTION OF DRAWINGS

[0017]

FIG. 1 is a cross-sectional view showing the entire structure of one preferred embodiment of spline teeth forming equipment to which the present invention is applied;

FIG. 2 is an enlarged cross-sectional view of part A in FIG. 1;

FIG. 3(a) is a perspective view of a blank before press-working; FIG. 3(b) is a perspective view showing a press-worked carrier plate; FIG. 3(c) is a cross-sectional view of the same carrier plate; FIG. 3(d) is a perspective view of a carrier plate on which spline teeth are formed; and FIG. 3(e) is a cross-sectional view of the same carrier plate.

FIG. 4 is an enlarged perspective view around the root of the boss portion;

FIG. 5 is an exemplary view showing the results of comparison in hardness between a machined portion and a workpiece;

FIG. 6(a) is an exemplary view showing a material flow in the circumferential direction of the boss portion according to the invention; and FIG. 6(b) is an exemplary view showing a material flow in the circumferential direction of the boss portion according to a prior art cutting;

FIG. 7 is a partial disassembled and perspective view of a part of an automobile transmission including a carrier plate to which the invention is applicable;

FIG. 8 is a partial disassembled and perspective view of an automobile transmission including a prior art carrier plate; and

FIG. 9 is a view showing a cutting method of spline teeth according to prior arts.

PREFFERED EMBODIMENTS OF THE INVENTION

[0018] Hereinafter, a description is given of a preferred embodiment of the invention with reference to the accompanying drawings. In addition, parts which are identical to those in the prior art technology are given the same reference numbers while different parts are given different reference numbers.

[0019] FIG. 1 is a view showing the entire structure of spline teeth forming equipment to which the invention is applied, FIG. 2 shows the major parts of the structure by using a perspective view and cross-sectional view, and FIG. 3(a) through (e) show changes in the shape of a carrier plate which is a workpiece in respective press processes by using perspective views and cross-sectional views.

[0020] First, in FIG. 3(a), a metallic blank 3' which is blank-cut to a developed view of a carrier plate 3 is provided with wall portions 4 formed so as to drop and a cylindrical boss 5 formed to be erect as shown in FIG. 3(b) and (c) via various kinds of press-working process thereafter. The boss portion 5 is caused to protrude from the front side at the center portion of a plate-like disk plate 3a, wherein the wall portions 4 are caused to protrude downward at the rear side of the circumferential edge of the disk plate 3a.

[0021] Thereafter, the carrier plate 3 are set at forming equipment 10 shown in FIG. 1 and FIG. 2. Also, in FIG. 1 and FIG. 2, the left side of the drawing paper shows a state before forming, and the right side thereof shows a state after forming.

[0022] Main parts of the forming equipment 10 is provided with a cylindrical die 14 on which teeth 12 for forming spline teeth are formed around its inner circumferential portion, a mandrel 16 disposed and fixed concentrically on the inner circumferential portion of the die 14, whose tip end is caused to protrude onto the upper part of the die 14, and a punch 18 for pressing a carrier plate 3, which is a workpiece on the upper part of the die 14, down to the inside of the die 14.

[0023] The inner diameter of the die 14, that is, the diameter between the teeth bottom of teeth 12 is equal to or slightly smaller than the outer diameter of the boss portion 5, and the height of the teeth 12 is set to a dimension within the thickness of the boss portion 5.

[0024] Further, the tip end of the punch 18 is formed to be inner cylindrical so as to be idly fitted to the mandrel 16. Also, the outer diameter of the mandrel 16 is equal to the inner diameter of the boss portion 5. The boss portion 5 is fitted into the upper protruding end, and the tip end of the boss portion 5 is opposed to the

tip end of the die 14, whereby a forming preparation of spline teeth is then completed.

[0025] From this state, the punch 18 is caused to drop and is brought into contact with the rear side of the boss portion 5, and by pressing the punch 18 down, the boss portion 5 is fitted into the clearance between the mandrel 16 and the die 14, whereby spline teeth 5a are formed on the outer circumference of the boss portion 5. That is, when the boss portion 5 is caused to drop along the mandrel 16, the outer layer portion of the boss portion 5 is drawn by the teeth 12 in the axial direction to form spline teeth 5a. At this time, the boss portion 5 is elongated in the axial direction due to a material flow, wherein the initial height H1 before machining as shown in FIG. 3(a) and (c) becomes a higher value H2 than the initial height after the machining as shown in FIG. (d) and (e). However, the inner diameter thereof still remains unchanged at the initial diameter by the mandrel 16. The thickness t2 after drawing and forming the boss portion 5 is equal to or slightly smaller than the thickness t1 before forming.

[0026] Further, the direction of flowing of the material resulting from a drawing and forming process is a direction from the tip end of the boss portion 5 toward the root side of the boss portion 5, and the reinforcement is concentrated here. However, the boss portion 5 extends in the axial direction, and the boss portion 5 from the tip end to the root becomes uniform in thickness.

[0027] In particular, as shown in FIG. 4, the drawn material forms minute build-up portions 5d, being semicircular in the plan view, which has a high hardness, on the outer circumferential surface at a position between a ridge and a ridge of the spline teeth 5a at the root of the boss portion 5.

[0028] Still further, after forming, the punch 18 is elevated. Subsequently, as shown in the right half of FIG. 2, a knock-out 20 is elevated to cause the carrier plate 3, on which spline teeth 5a are formed, to be thrust up and separated from the mandrel 16. Herein, one forming cycle is completed.

[0029] Thereafter, an opening, etc., which pivotally supports a planetary gear 6, is formed, and appointed gears are assembled to be integrated altogether, wherein by welding them to the base plate 2, a carrier plate assembly 1A shown in FIG. 7 is obtained.

[0030] FIG. 5 shows hardness (Vickers hardness) at respective points on the section cut off in the longitudinal direction at ridge portions of teeth of the boss portion 5 obtained by the abovementioned forming process. The hardness in the drawing shows the hardness at a depth of 0.05cm from the respective surfaces and the hardness at the center of the thickness. The hardness on the drawing surface, that is, at the spline teeth portion 5a of the boss portion is generally higher than the hardness at non-machined or non-drawn portions, and the hardness at the outside of the root portion of the boss portion 5 shows the maximum value. An increase in strength can be confirmed.

[0031] Further, FIG. 6 exemplarily shows a flow material in the circumferential direction of the boss portion in a machined state. A cross section of the boss portion according to a method of the invention shows a flow of a material compressed toward the center of the diameter as shown in FIG. 6(a). However, as shown in FIG. 6(b), in the prior art cutting, teeth are formed in the form of separating the material flow. As the result of a comparison, it can be found that the hardness of the teeth can be increased by the method according to the invention.

[0032] Also, in the above preferred embodiment, a description was given of the case where spline teeth are formed on the outer circumference of the boss portion of a carrier plate. However, the invention is widely applicable to other torque transmitting members, for constituting an automobile transmission, in which spline grooves are formed on the outer circumference of the cylindrical boss portion integrally formed at a disk plate.

INDUSTRIAL APPLICABILITY

[0033] As has been made clear on the basis of the above description, with a torque transmitting member in an automobile transmission according to the invention, the surface hardness of spline teeth on the outer circumferential surface of the boss portion is harder than the hardness of non-machined surfaces, and the hardness becomes maximum at the root side of the boss portion. In addition, since the thickness of the root of the boss portion can be sufficiently secured, the strength of the boss portion is high in comparison with the prior arts, whereby it is possible to prevent, in advance, such problems as breakage at the tooth portion.

[0034] Furthermore, with a method according to a spline teeth forming method of the invention, the boss portion is drawn in the axial direction after it is inserted into a clearance between a die and a mandrel, and teeth can be drawn and formed while the surface material of the boss portion is caused to flow. Therefore, since spline teeth can be completed by only a one-shot punching operation, the machining process can be completed with only one process in comparison with prior art cutting, and continuous forming can be carried out by a thorough press-working process from coil materials. The machining cost can be remarkably decreased.

[0035] Further, with spline teeth forming equipment according to the invention, since initial position of workpieces can be secured by a mandrel, there are other advantages such as, for example, high machining accuracy, etc.

Claims

1. A torque transmitting member in an automobile transmission, having a cylindrical boss integrally formed at the center of a metallic disk plate so as to

protrude therefrom and having spline teeth formed on the outer circumference of said boss, wherein said spline teeth are formed so that their outer-layered portion is drawn from the tip end side of said boss in the axial direction.

2. A torque transmitting member in an automobile transmission, as set forth in Claim 1, wherein said torque transmitting member is a carrier plate for automatic transmission, in which its wall portions welded to and fixed at a base plate are provided at a plurality of points in the circumferential direction.

3. A method for forming spline teeth on the outer circumferential surface of a boss of a workpiece on which a cylindrical boss is integrally formed at the center of a metallic disk plate so as to protrude therefrom, wherein with respect to a cylindrical die on which teeth for drawing and forming spline teeth are formed, and a boss guide mandrel disposed at the center of said die, a disk plate for a workpiece, in which the boss is disposed so as to be fitted into the mandrel is pressed by a punch, the boss is fitted in a clearance between the die and the mandrel, and spline teeth are drawn and formed on the outer circumferential surface of the boss.

4. Equipment for forming spline teeth comprising; a cylindrical die on which teeth for drawing and forming spline teeth are formed; a boss guide mandrel, which is disposed and fixed at the center of said boss; and a punch which is elevated along said mandrel and causes a boss engaged in said mandrel to be inserted into a clearance between said die and said mandrel.

FIG. 1

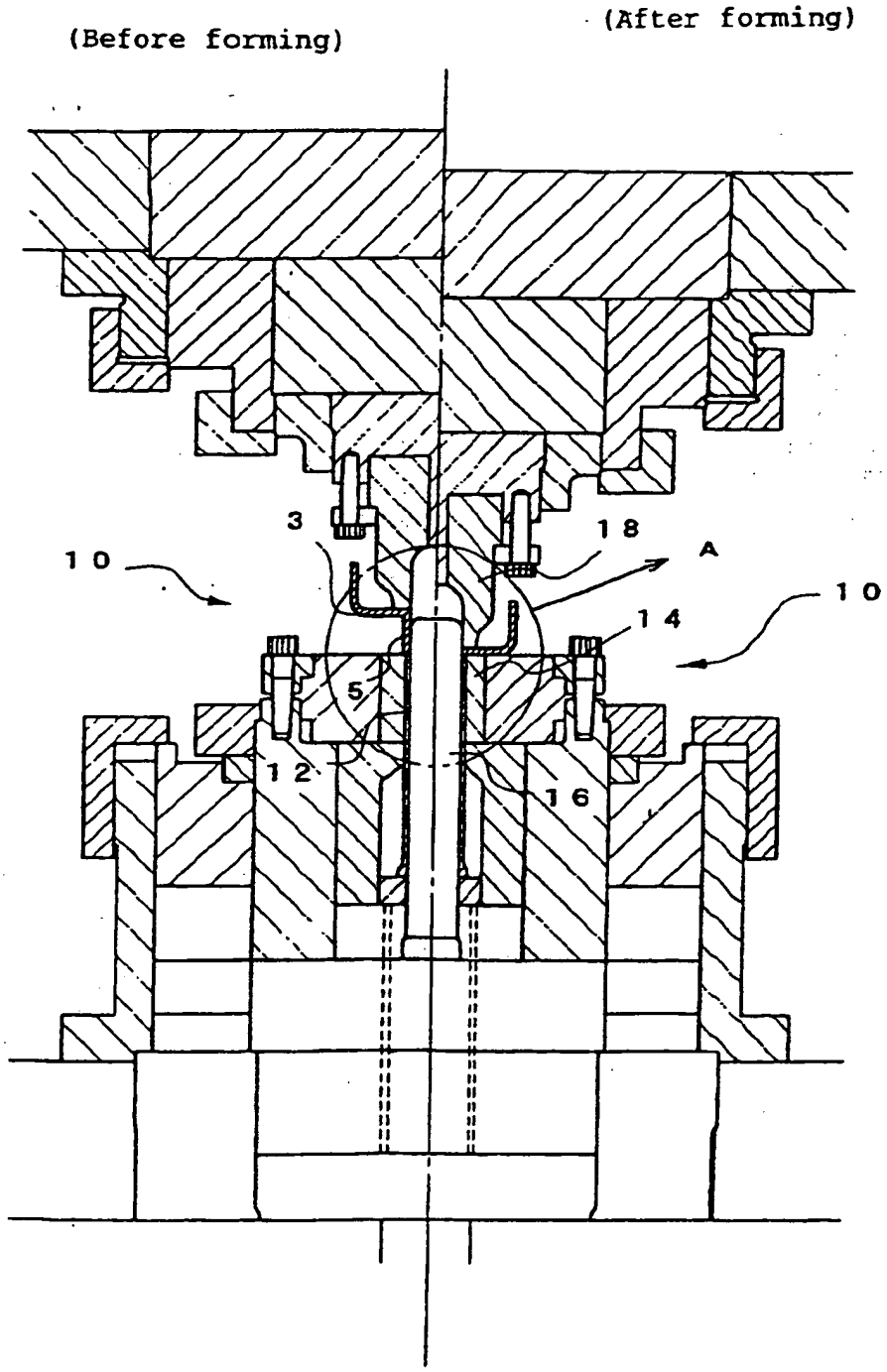
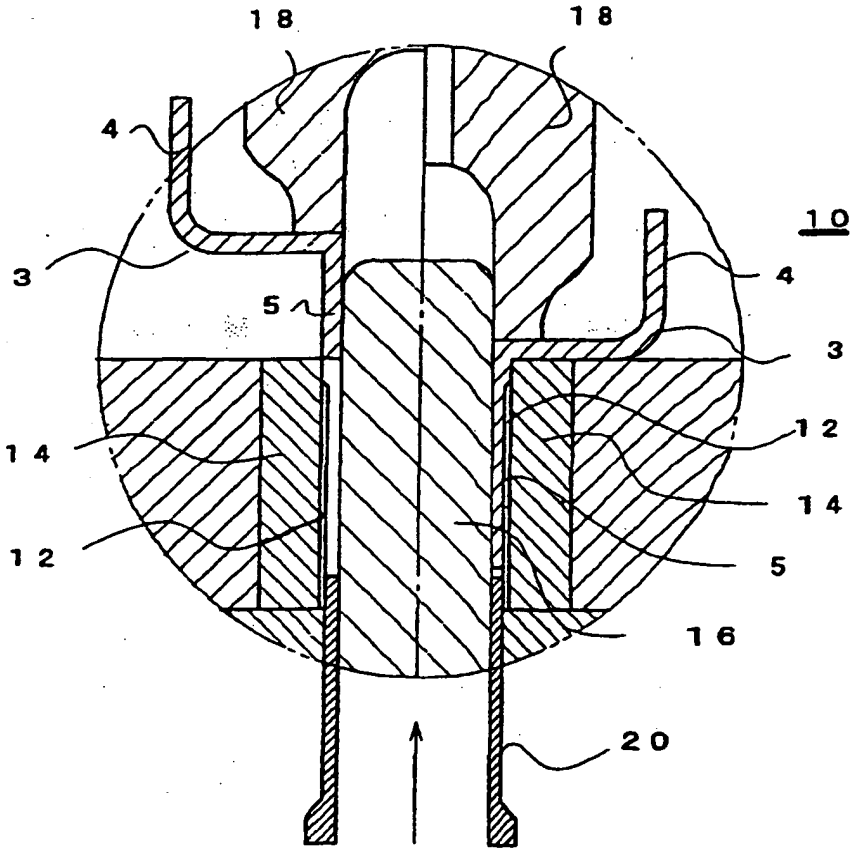


FIG. 2



(Enlarged view of Portion "A")

FIG. 3

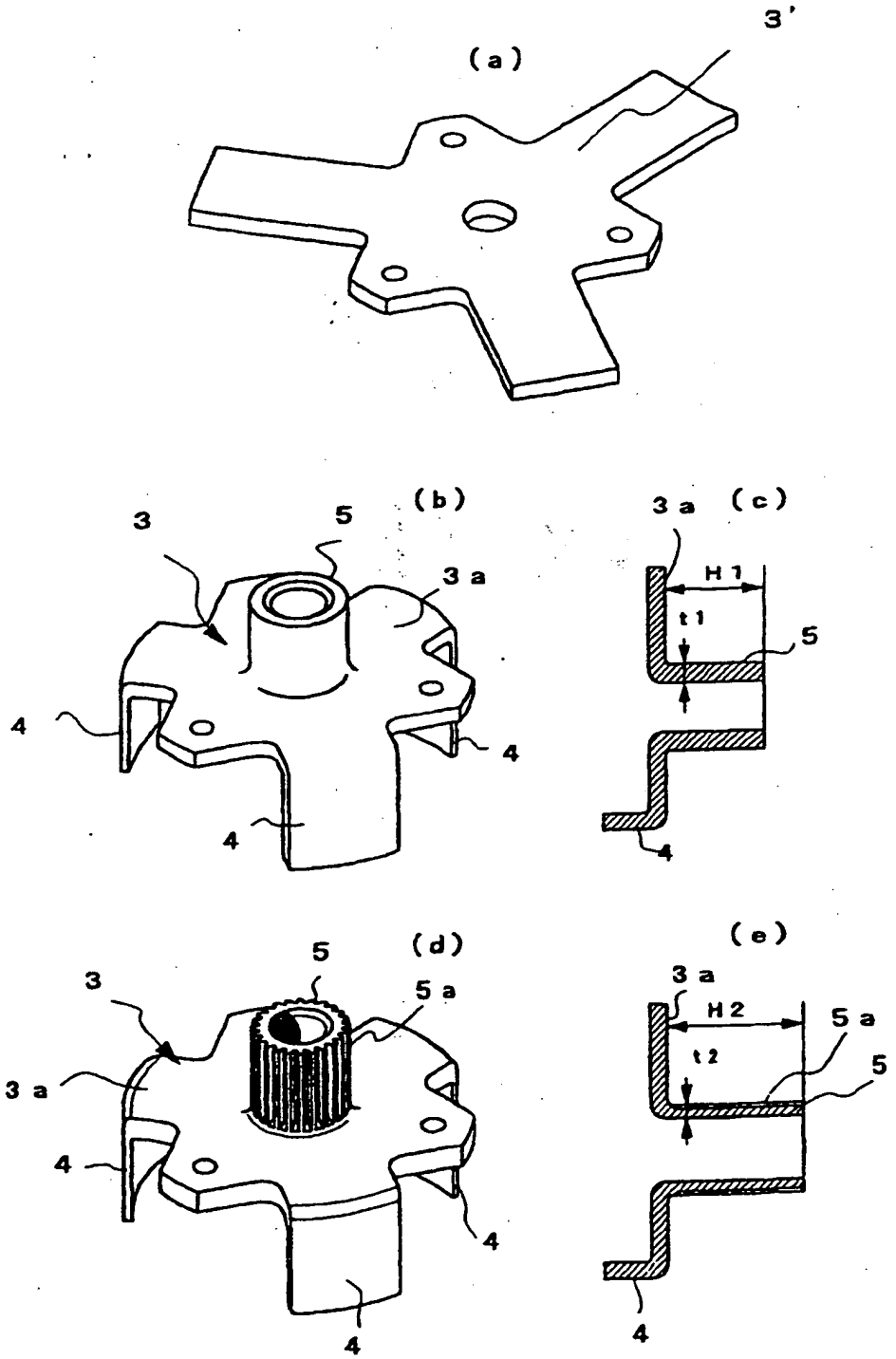


FIG. 4

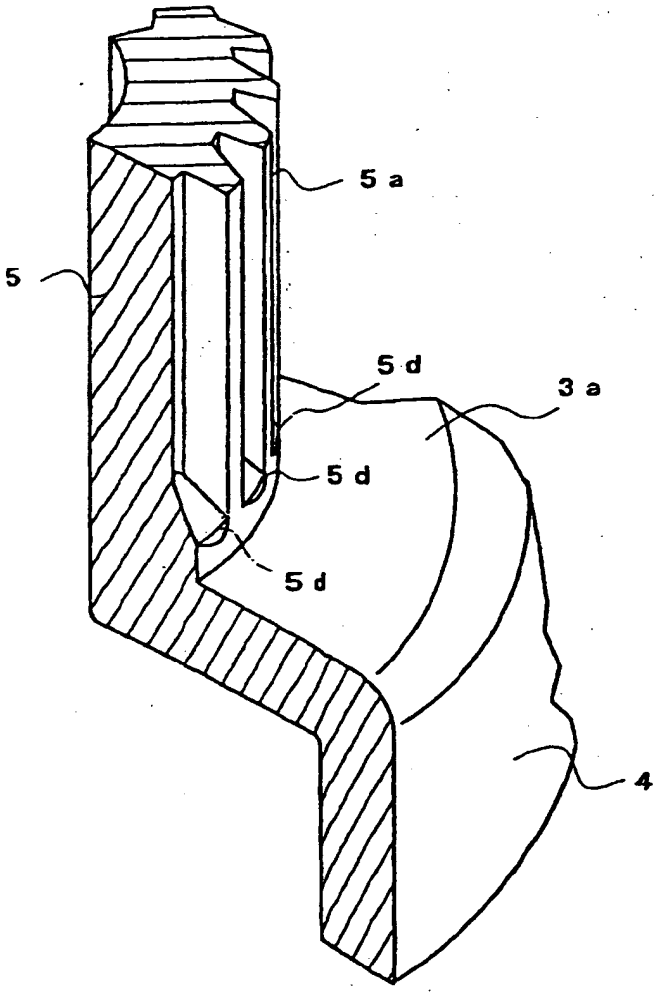


FIG. 5

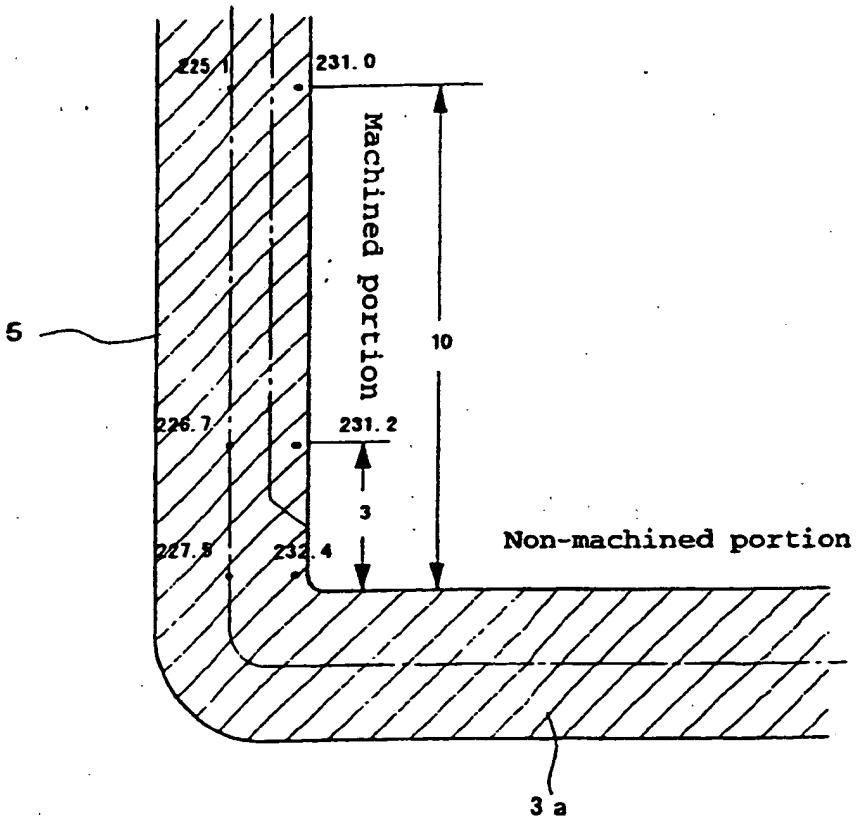

225.1
231.0
Machined portion
10
5
226.7
231.2
3
227.8
232.4
Non-machined portion
3 a

FIG. 6

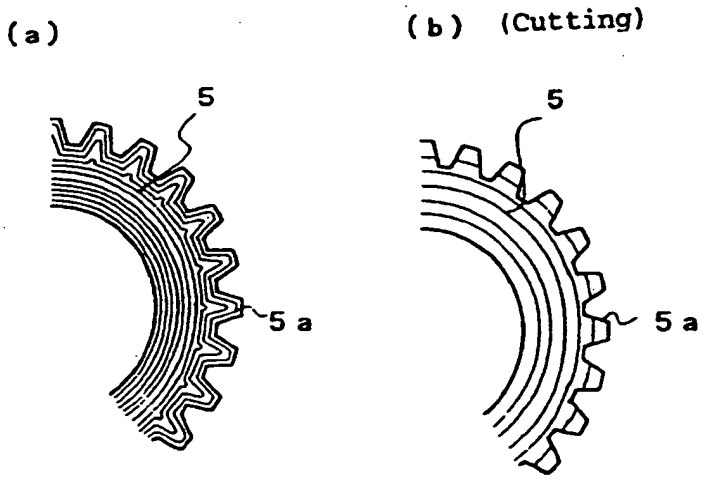

(a)
(b) (Cutting)
5
5 a
5
5 a

FIG. 7

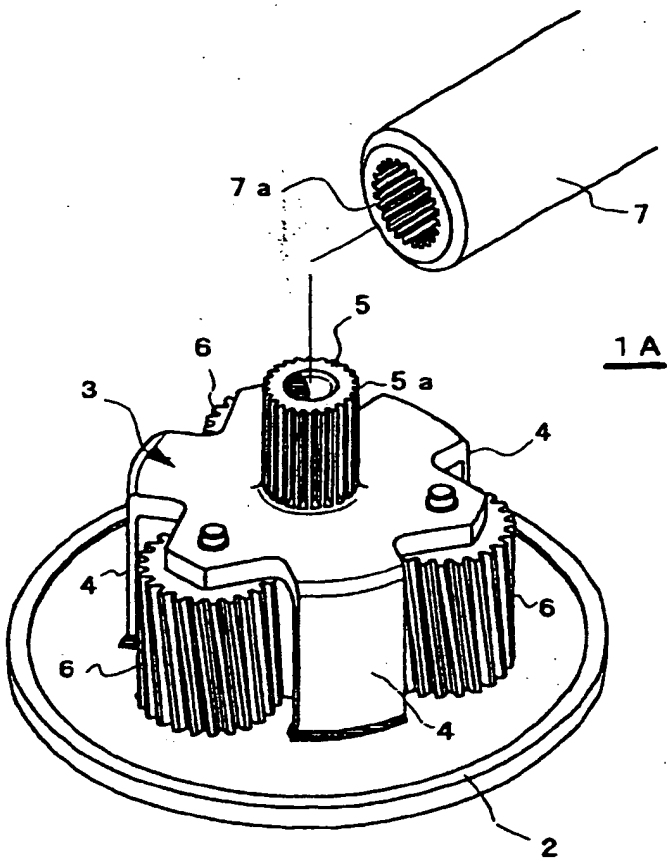


FIG. 8

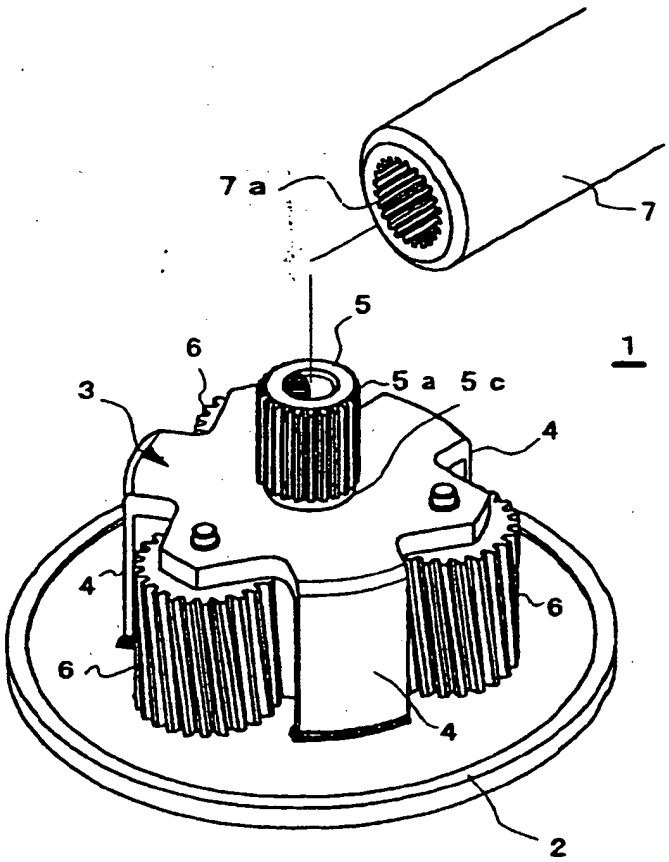
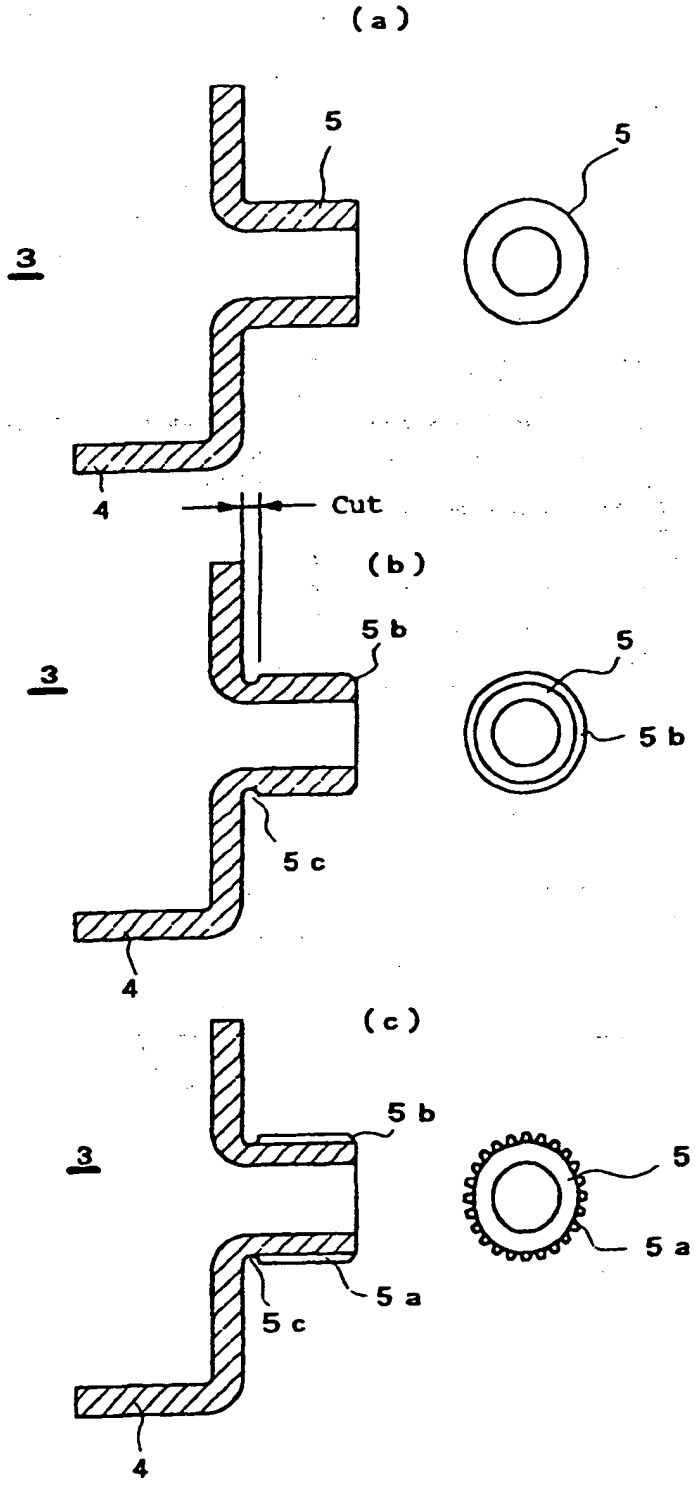


FIG. 9



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP98/02144

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[6] F16D1/02, F16H1/28, B21D22/30, B21K1/30

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[6] F16D1/02, B21D22/30, B21K1/30

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1940-1996 Toroku Jitsuyo Shinan Koho 1994-1998
Kokai Jitsuyo Shinan Koho 1971-1998 Jitsuyo Shinan Toroku Koho 1996-1998

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 105457/1986 (Laid-open No. 11126/1988) (Mazda Motor Corp.), January 25, 1988 (25. 01. 88), Page 4, lines 1 to 10 (Family: none)	1-4
Y	JP, 62-168626, A (Yamaha Motor Co., Ltd.), July 24, 1987 (24. 07. 87), Page 2, lower left column, lines 14 to 18 (Family: none)	1-4
Y	JP, 60-84443, A (Nissan Motor Co., Ltd.), May 13, 1985 (13. 05. 85), Page 2, upper left column, line 13 to upper right column, line 2 (Family: none)	1-2
A	JP, 5-318188, A (President of Nagoya Institute of Technology, Toho Gas Co., Ltd., Morita and Company), December 3, 1993 (03. 12. 93) (Family: none)	1-4

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited document:
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"P" document published prior to the international filing date but later than the priority date claimed
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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
July 28, 1998 (28. 07. 98)	August 11, 1998 (11. 08. 98)
Name and mailing address of the ISA/ Japanese Patent Office	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP98/02144

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP, 8-300084, A (Yamakawa Industrial Co., Ltd.), November 19, 1996 (19. 11. 96) (Family: none)	1-4

Form PCT/ISA/210 (continuation of second sheet) (July 1992)